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Basin-Wide Oceanographic Array Bridges the South Atlantic

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Abstract :

The meridional overturning circulation (MOC) is a global system of surface, intermediate, and deep ocean currents. The MOC connects the surface layer of the ocean and the atmosphere with the huge reservoir of the deep sea and is the primary mechanism for transporting heat, freshwater, and carbon between ocean basins. Climate models show that past changes in the strength of the MOC were linked to historical climate variations. Further research suggests that the MOC will continue to modulate climate change scenarios on time scales ranging from decades to centuries [Latif *et al.*, 2006].

Keywords : South Atlantic ; Meridional Overturning Circulation ; CPIES

(MOCHA), part of the U.S. National Oceanic and Atmospheric Administration's (NOAA) Western Boundary Time Series program. Preliminary results from this array of sensors, which extends across the North Atlantic along 26.5°N, have shown that the strength of the overturning circulation varies considerably on time scales as short as weeks to months [Rayner *et al.*, 2011].

Given the complex, multibasin nature of the MOC, achieving a more complete understanding of its behavior requires a more comprehensive observing system, one that extends across neighboring ocean basins. Though Argo floats, gliders, and satellite measurements continue to revolutionize

At present, the majority of observations of the MOC come from the Rapid Climate Change (RAPID) MOC/Meridional Overturning Circulation and Heat Flux Array

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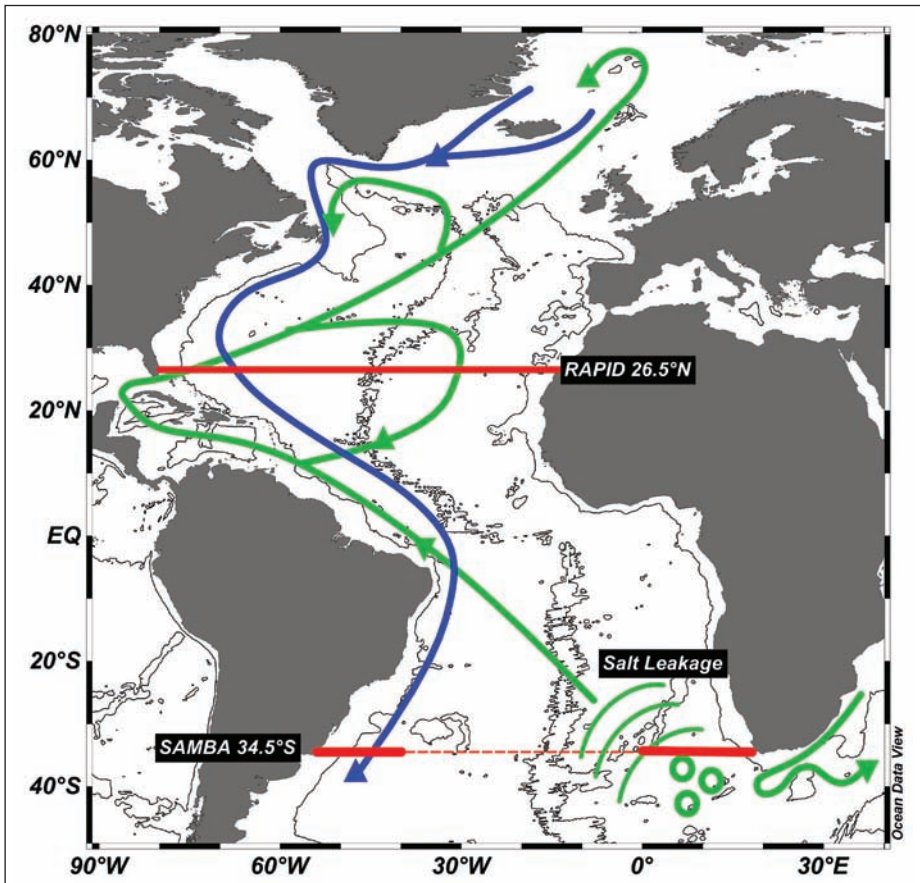


Fig. 1. A simplified schematic highlighting the meridional overturning circulation (MOC)—how currents flow between the southern and northern Atlantic Ocean. Blue lines refer to the pathway of the cold, deep water masses formed in the northern Atlantic; green lines correspond to the northward surface flow (including the Agulhas Current system south of Africa). Agulhas rings (green circles) and their saline influence into the eastern South Atlantic (green arcs) are shown. The existing South Atlantic MOC Basin-wide Array (SAMBA) array along 34.5°S is shown as a solid red line, and the proposed full transect, to be completed in 2014 and 2015, is shown as a dashed line. The Rapid Climate Change (RAPID) MOC/Meridional Overturning Circulation and Heat Flux Array (MOCHA), part of the U.S. National Oceanic and Atmospheric Administration's Western Boundary Time Series program (RAPID MOC/MOCHA/WBTS, referred to here as RAPID), in the North Atlantic is shown also as a solid red line along 26.5°N. Schematic adapted from Zahn [2009].

the study of the upper ocean, there is still a clear need to study the full ocean depth with moored instruments. Recognition of this critical importance led to the creation of the South Atlantic MOC (SAMOC) initiative [Garzoli et al., 2010].

The Importance of 34.5°S

The current exchange pathways south of Africa and South America drive water mass interactions between the Indian, Pacific, and Atlantic oceans. Specifically, recent model simulations suggest that the leakage of Agulhas Current water across 34.5°S into the South Atlantic is important to circulation patterns far afield [Biaostoch et al., 2008]. The Agulhas Current, which flows westward around the southern coast of South Africa, contributes strongly to the upper limb of the MOC northward flow in the Atlantic Ocean. Additionally, the shedding of Agulhas rings into the eastern South Atlantic is a major source of salinity to the region (Figure 1). Other investigations suggest that variability in Agulhas Current leakage may correlate to changes in the strength of the North Atlantic MOC [Biaostoch and Böning, 2013].

Thus, researchers have identified 34.5°S in the South Atlantic as the latitude most crucial to any examination of how interocean exchange influences the MOC [Schiermeier, 2013]. Part of the SAMOC initiative includes deploying a transbasin mooring line along 34.5°S that will over time span the entire South Atlantic. Known as the South Atlantic MOC Basin-wide Array (SAMBA), this mooring array captures the Agulhas ring corridor and is aimed at monitoring long-term physical and chemical changes within the western and eastern boundary current systems as well as the effect of interocean exchange on the MOC (Figure 1).

Full basin-wide arrays, such as SAMBA, provide crucial data through long-term monitoring that will be key to understanding how the ocean and the MOC influence global climate.

The Growth of SAMBA

Starting in 2009, the United States, Brazil, and Argentina deployed the first four pressure inverted echo sounders (PIES) and three current and pressure recording inverted echo sounders (CPIES) in the western South Atlantic (Figure 1). The CPIES and PIES array, positioned on the seafloor, records acoustic travel time, bottom pressure, and current velocity at the base of the water column. From these measurements and hinging on the fact that acoustic signals measure the speed of sound throughout the

water column, full-depth profiles of temperature and current velocity can be inferred.

In September 2013, French and South African scientists deployed an array of eight CPIES moorings along the eastern portion of the SAMBA line from the South African R/V *SA Agulhas II*. In December 2013, Brazil added additional moorings to augment this array, including a bottom pressure gauge and a bottom-mounted acoustic Doppler current profiler. Data from all PIES and CPIES can be collected acoustically by research ships, with some instruments also equipped with “data pods” that automatically release to the surface every 4 months, transmitting their data via satellite.

In mid-2014, South Africa will deploy a line of tall moorings along the eastern end of the SAMBA line, extending from the continental shelf edge to 15°E. When deployed, each deep-sea mooring will extend from the seafloor to the surface and will measure temperature and velocities throughout the water column. Many of these moorings will be deployed at depths exceeding 4500 meters. In 2014 and 2015, repeat oceanographic surveys and further deployments are also planned along the entire SAMBA line.

Data from SAMBA will help researchers develop models of how Agulhas Current leakage influences the strength of the MOC, as well as provide the community with accurate information on how the transport of Indian Ocean water masses into the South Atlantic varies annually. As SAMBA continues to grow, supported by an international collaboration, scientists will get closer to understanding the behavior of the MOC and its role in driving climatic variability.

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for the deployment of the eastern array of CPIES, data pods, and acoustic Doppler current profilers. The authors would like to extend their appreciation to the officers, crew, and technicians who have supported the western portion of the SAMBA line, particularly the Brazilian vessels *N. Oc. Alpha-Crucis* and *N. H. Cruzeiro do Sul* and the Argentine vessel *ARA Puerto Deseado*. Figure 1 is drawn using Ocean Data View software (R. Schlitzer, 2011, Ocean Data View, <http://odv.awi.de>).

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